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Statistical Analysis of an Attitude Scale to Measure Patient Satisfaction With Medical Care

Life Satisfaction and Chronic Disease: Exploration of a Theoretical Model

Refinements in the Measurement of Health-Specific Locus-of-Control Beliefs

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MEDICAL CARE
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Original Articles

DRG-Based Reimbursement: The Use of Concurrent and Retrospective Clinical Data

CYNTHIA BARNARD, B.A.,* AND TRUMAN ESMOND, M.S.†

The Health Care Financing Administration is developing a new method of Medicare patient reimbursement limit setting, based on a quantification of hospital case mix through the AUTOGRP Diagnosis-Related Groups established at Yale University. The reliability of this method is dependent on the diagnosis and procedure data used as input, which should reflect the "principal" condition of the patient. HCFA's source of data is Medicare billing for 1978, some of which contains concurrent rather than retrospective diagnosis and procedure information. Billing data from one large teaching hospital are examined with respect to Medical Records data. The data are evaluated, based on the diagnosis and procedure codes and on the groupings (DRGs) presently being used by HCFA; concurrent and retrospective data are found to be widely divergent on both measures. An apparent difference in complexity or extent of resource use is noted, suggesting that the data being used in HCFA's development effort may not fully represent the level of complexity of cases being treated and that reimbursement based on this data may be incorrect.

IN RESPONSE TO THE REQUESTS of hospitals for a more appropriate system of reimbursement and to pressure from the federal government for a reduction in health care costs, the Health Care Financing Administration is in the process of developing a replacement for its current reimbursement mechanism for Medicare inpatient stays. This replacement has as its key attraction the establishment of reimbursement rates based on case mix, or the complexity of the cases treated in the institution over some period of time. It is intuitively obvious, say the proponents of this strategy, that costs are not uniform for the treatment of all diseases.

The methodology that is to be used to quantify case mix is one that was developed at Yale University and that is receiving a good deal of attention as the basis for New Jersey's present case-mix reimbursement experiment.[1] It was selected from a variety of case-mix measurement techniques that have been developed to aid in the evaluation of quality of care, resource needs, etc. Diagnosis-Related Groups (DRGs) are aggregates of patients based on five factors: age, principal and secondary diagnoses, principal and secondary procedures. They are claimed to be

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medically meaningful groups, with internally homogeneous patterns of length-of-stay.

The purpose of the present study is not the validation or discrediting of the DRG methodology per se, but rather a review of the appropriateness of the data utilized in its application. The following pages review evidence that the data being used by HCFA to develop DRG cost protocols and budgets may be of poor quality with respect to their present use, that is, not appropriate for DRG classification. These data consist of diagnosis and procedure information supplied on the final Medicare bill for an inpatient stay.

The areas of focus in this study are:

The ambiguity inherent in use of diagnosis and procedure coding schemes, and their replicability;

The source of Medicare bill data, and their relevance to DRG assignment;

Financial and case-mix implications of discrepancies between billing data and Medical Records data.

The Reliability of Coded Data

A variety of analyses have been performed to assess the validity of diagnosis and procedure assignment. These generally focus on the accuracy of the process that translates a physician's description of a disease or procedure into a standard code.† Estimated rates of error in this process vary from 5 per cent to as much as 34.8 per cent and higher.[2] The data supplied on the Medicare bill [form HCFA-1453(c); see Figure 1] are an English description; thus, HCFA is performing a coding process and runs the risk of error. The diagnosis and procedure descriptions are written on the bill according to no uniform standard; the physician's text is transcribed from the record. Corn[3] points out that 20 per cent of these descriptions are computer-coded into ICD codes§ and that the remainder are coded manually.

In 1977 a study was performed to audit ICD codes submitted on Medicare and Medicaid bills from 50 hospitals.[2] In only 66.8 per cent of the cases was the original diagnosis coding confirmed. The discrepancies between original coding and audit coding were usually due to "a difference of professional opinion in interpreting the medical record," suggesting that "for any aggregate sample of abstracts, a sizable portion will not be reliable in the sense of being coded similarly on repeated occasions. Furthermore, there is no identifiable or correctable 'error.'"[2] A later study found the same situation.[4]*

Since Medicare does not use coded data from the hospitals, hospital-specific "error rates" cannot be determined. Medicare coders may or may not distribute "errors" across hospitals. If Medicare did request codes from hospitals, audits of each facility would be possible, intrafacility consistency would be more assured and constructive activity to achieve interfacility

† The coding scheme is called the International Classification of Diseases (adapted for use in the U.S.), or ICDA. In January 1979, Medicare stopped using the eighth revision of the system (ICDA-8) and began using the ninth, with "Clinical Modifications" (ICD-9-CM).

§ Julian Pettengill, from HCFA Office of Research, informs us that "the correct figure is about 50 per cent" for computer-coded diagnoses and procedures.

‡ Reasons for diagnosis code discrepancy:

professional opinion (on the code or the sequence of diagnoses):	47.6 per cent
specific hospital interpretation, procedure or policy:	42.2 per cent
other:	10.2 per cent

Reasons for procedure code discrepancy:

professional opinion:	35.1 per cent
policy:	53.1 per cent
other:	11.8 per cent

* This study found a 39 per cent "error" rate on principal diagnosis (all four digits), of which 79 per cent was attributable to judgment or procedural differences.

INPATIENT HOSPITAL AND SKILLED NURSING FACILITY ADMISSION AND BILLING
HOSPITAL AND MEDICAL INSURANCE BENEFITS SOCIAL SECURITY ACT

Form Approved OMB No. 068-R0014

This report is authorized by 42 USC 1395f, 42 CFR 405.1661. Your cooperation is needed to keep proper benefit payment records and to make proper Medicare payments.
NOTICE: Anyone who misrepresents or falsifies essential information requested by this form may upon conviction be subject to fine and imprisonment under Federal law.

1. Patient's last name	First name	MI	2. Sex ☐M ☐F	3. Health insurance claim number
4. Patient's address (Street number, City, State)		Zip Code	5. Date of birth	6. Medical record number
7. Date of this admission	8. Provider name and address (City and State)		9. Provider number	10. Attending physician
11. Dates of qualifying stay FROM / THRU	12. Qualifying and other prior stay information			

If any of your medical expenses may be paid by your insurance organization or State Agency, complete items 13 and 14. If you do not want information about this Medicare claim released to your insurance organization, check this block ☐

13. Name and address of organization or agency	14. Policy or Identification Number

15. Patient's Certification, Authorization to Release Information, and Payment Request. I certify that the information given by me in applying for payment under Title XVIII of the Social Security Act is correct. I authorize any holder of medical or other information about me to release to the Social Security Administration and/or the Medicare Program or its intermediaries or carriers any information needed for this or a related Medicare claim. I request that payment of authorized benefits be made on my behalf.

Signature (Patient or authorized representative) (Signature by mark must be witnessed)	☐ Contained in provider's record	Date

16. Admitting diagnoses	Employment Related and or Entitlement to Other Government Programs ☐ Yes ☐ No (If Yes, Give Name and Address of Employer and or Program)	Do not use this space
17. (a) Principal diagnosis	(b) Other diagnoses	
18. Surgical procedures (Show date of each)		

19. STATEMENT OF SERVICES RENDERED

	Blood pints furnished A	Pints replaced	Not replaced	Charge per pint	Total Charges	Non-Covered Chgs.
	Accommodation		Days	Rate		
B	1-Bed					
C	2-3-4 Bed					
D	5 or more Beds					
FOR HOSP ONLY	E. Intensive care					
	F. Coronary care					
	G					
	H. Operating room					
	I. Anesthesia					
	J. Outpatient services					
K. Blood administration						
L. Pharmacy						
M. Radiology						
N. Laboratory						
O. Medical surgical and central supplies						
P. Physical therapy						
Q. Occupational therapy						
R. Speech pathology						
S. Inhalation therapy						
T. Other (Describe)						
U. TOTALS						
V. Inpatient deductible						
W. Blood deductible pts @						
X. Coinsurance days ( )						
Y. TOTAL DEDUCTIONS						

20. Statement covers period FROM	THRU
21. Date guarantee of payment began	22. Date UR notice received
23. Date active care ended	24. Date benefits exhausted
25. Patient status: A. Date discharged	B. Date of death / C. ☐ Still patient
26. Lifetime reserve days	27. Non-covered days / 28. Covered days
30. Remarks	

P.I.P. A. ☐

29. I certify that the required physician's certification and recertifications are on file

Signature of provider representative	Date Received	31. Reimbursement amount $

FOR INTERMEDIARY USE

32. Verified non-covered stays From / Thru	33. Non-pmt. code	34. Days used
35. Approved by	Date approved	

Form HCFA-1453 (C) (1-80) (Formerly SSA-1453C) Department of Health, Education, and Welfare Health Care Financing Administration

FIG. 1.

consistency would be more easily implemented.[¶]

The 1977 Institute of Medicine study also focused on the issue of problems in coding that might be unique to Medicare: "abstracts for Medicare patients tended to be less reliable . . . Medicare patients are usually older and tend to have multiple diagnoses; this may explain the generally lower reliability. . . ."[2]

The picture that emerges is one in which professional judgment plays a significant role in code assignment, in which there is as a result some variability and lack of standardization, and in which there is apparently a higher rate of error when a complex case, presenting multiple problems, is coded. It seems reasonable to question the use of such data for reimbursement; we will discuss below the extent to which DRG aggregation eliminates some of the data problems.

The Problem of Definition

The Uniform Hospital Discharge Data Set (UHDDS) was developed for the U.S. National Committee on Vital and Health Statistics.[5] This document contains definitions of diagnoses and procedures, and the meaning of the term "principal."

> Principal diagnosis is . . . the condition established after study to be chiefly responsible for occasioning the admission of the patient to the hospital for care. . . . The principal procedure is one that was performed for definitive treatment . . . [and] is that procedure most related to the principal diagnosis.

Possibly the most important element of this definition is contained in the words "after study." Principal diagnosis refers to the outcome of a *retrospective* review process, conducted after patient discharge and based on all available data about the stay.

There are several alternatives to principal diagnosis when describing a patient. The "primary" diagnosis (the similar term is to be deplored and is responsible for a good deal of confusion) is "the one diagnosis, but not necessarily the principal diagnosis, that describes the most important or significant condition of a patient in terms of its implications for his health, his medical care, and his use of the hospital."[6] It is not clear from the UHDDS whether such a diagnosis could be established *during* a hospitalization, or whether this is a retrospective determination like that of the "principal" diagnosis.

The UHDDS devotes a thoughtful discussion to yet another type of diagnosis, the "presenting diagnosis or problem," which is concurrently determined and represents, at the time it is recorded, "the highest level of certainty supported by available clinical information." This diagnosis is the outcome of concurrent (e.g., Utilization Review) study and is the basis for decisions concerning the treatment regimen.

It is instructive to compare this 1980 version of the UHDDS to an earlier (1973) version,[7] in which "the recent development of problem-oriented records" (concurrently recorded) is noted. The 1973 version also anticipates future concerns of diagnosis-based research and patient management:

> Of all the items in the data set, the clear identification of diagnoses was considered of the greatest importance . . . standardization is an essential requirement for achieving comparability of data. . . .

As one observer has noted, "the Medicare definition of the principal discharge diagnosis does not appear to conform to the UHDDS. Medicare requires the hospital to report the condition that was the primary reason for the patient's *hospitalization*, rather than the primary reason for the patient's *admission* . . . the Medicare definition is somewhat vague."[3]

This vagueness has never been a problem, since the diagnostic data on the Medi-

[¶] HCFA has begun the conversion effort to accept coded data from hospitals.

care bill have never been used in such a way as to impact providers. A DRG-based reimbursement strategy, however, will change all this. Clearly, Diagnosis-Related Groups must be based upon the diagnosis and procedure information, which is the best determinant of resource consumption. To date, uniform standards for bill completion have not been disseminated to providers.

The Problem of Timing

The critical issue appears to be one of *timing*. In order to perceive this problem clearly, it is helpful to recall that the legislation mandating utilization review (PL 92-603, 1972) has been widely criticized for its fuzziness and apparent concern for cost-containment above quality assurance: "From the beginning SSA avoided enforcement of a qualitative review process, [and] treated utilization review as an audit of claims for payment rather than of professional practice."[8]

The relevance of these perspectives is evident when one reflects that *the source for the diagnosis and procedure information on the Medicare bill is often Utilization Review*, and Utilization Review evaluators are concerned with *concurrent*, not *retrospective*, diagnoses.

Fiscal survival dictates that all third-party payors be billed as soon after discharge as is practical—that is, as soon as all late charges have been posted. At Rush-Presbyterian-St. Luke's Medical Center (RPSLMC), a 1200-bed academic medical center in Chicago, Medicare bills are produced on the fourth day after discharge. Staff in the billing office use the computerized Utilization Review system to enable them to put the clinical data on the bills, since the medical record is not always completed at this point. The "current or discharge" diagnoses and procedures requested on form 1453 are thus available to HCFA—but they are often "current" as of a few days before discharge.

Medicare's attention to clinical data has always been cursory, and it seems fair to suggest that no institution will delay receivables collection in order to validate unaudited codes. The legion problems of timely medical record completion are well known, and there has never been a reason to hold Medicare bills up to 45 days (the PSRO requirement) or longer, waiting for the discharge diagnosis to be coded.

The Medicare Periodic Interim Payment (PIP) program requires that 90 per cent of patients' final bills be submitted within 30 days of discharge. In fact, Medicare has recognized this operational difficulty: "The intermediary may authorize the hospital to use the 'working' diagnosis (instead of the 'final diagnosis') to speed the submission of bills."[9] In short, some hospitals have used *concurrent* diagnosis and procedural data; others have used *retrospective* data. There is no doubt that only the latter is unquestionably suitable for DRG classification.

At the study hospital, Rush-Presbyterian-St. Luke's Medical Center, the validity of the codes that are entered by Utilization Review appears to be equal to that of the codes entered in Medical Records (based on informal audits conducted periodically by the directors of both departments). However, the coding activity serves different purposes. In Utilization Review, the goal is to establish the primary current problem, so that the timeliness of discharge may be reviewed. In Medical Records, the goal is to code "the diagnosis of the condition established after study to be chiefly responsible for occasioning the admission of the patient to the hospital for care."[6]

The RPSLMC Study

The foregoing tends to suggest that the data supplied to HCFA via form 1453, the Medicare bill, may be inappropriate for use in defining a reimbursement methodology, since distributions based on the data

may be skewed. Because of its historical lack of importance, it may not be audited or validated by most hospitals, and because of the need to prepare Medicare bills on a timely basis, the data submitted may have been concurrent, not retrospective, data.

Objectives of the Study

A study was conducted at RPSLMC to compare billing data (concurrently determined and submitted to HCFA four days after discharge) with Medical Records data (retrospectively determined after discharge). The goal was to evaluate the extent to which concurrently collected data could reliably be substituted for retrospective data. Since HCFA is using diagnostic data to set up reimbursement protocols, we were particularly interested in the impact on reimbursement of concurrent data submission. In other words, if diagnostic data are used to set reimbursement levels, and an alternate source of data is used, what is the resulting effect on those reimbursement levels?

Dimensions of the Study

The data used for the study were complete medical records and utilization review records for approximately 3,000 Medicare inpatients discharged from RPSLMC during the year beginning May 1, 1979. This represented a random 50 per cent sample of the year's Medicare inpatients.

The two sets of data were merged by patient number (a combination of medical record number and a unique number representing a particular stay). The resulting data are presented in Table 1.

The data were entered in the GROUP computer program, yielding a concurrent DRG and a retrospective DRG, based on the two sets of codes.**

Results: Comparing the Raw ICD Codes

Based on the assumption that Medical Records coding reflects the accurate retrospective or discharge data, an attempt was made to compare the Utilization Review data—which are used on the Medicare bill—with this "criterion" data, in order to determine whether there are differences and, if so, the impact of those differences on reimbursement. The comparison was limited to the "integer" portion of the ICD code (up to three digits), making it as generous as possible, on the theory that the specificity provided by the two decimal places would be irrelevant to DRGs.

The question asked appears to be a simple one: for how many patients was con-

** In order to be grouped, the codes had to be converted from the ICD-9-CM scheme to HICDA-2. No computer software—or manual methodology—has yet been developed to derive DRGs from ICD-9-CM codes. (A project to do this is presently underway, with HCFA funding.) The New Jersey Department of Health faces this issue in their DRG-based reimbursement system and kindly supplied RPSLMC with a conversion tape listing the ICD-9-CM codes and equivalent HICDA-2 codes.

Two documents from the New Jersey Department of Health describe the conversion strategy (the user must write the software to implement the conversion tape) and the Grouper strategy. Both are titled "A Prospective Reimbursement System Based on Patient Case-Mix for New Jersey Hospitals 1976–1983"; one is subtitled "DRG Assignment Using ICD-9-CM Codes: 1980 GROUPER Logic," and the other is subtitled "GROUPER INSTALLATION (for Modified HICDA-2 GROUPER)." Both documents are dated November 15, 1979 and are published by the Department of Health.

TABLE 1.

Both	Utilization Review (concurrent, used for billing)	Medical Records (retrospective)
Patient number	up to 5 diagnoses	up to 8 diagnoses
Age	up to 5 procedures	up to 8 procedures

current coding the same as retrospective coding?

Our input consisted of two diagnoses and two procedures (one of each designated "principal" by the coder). For each of these four codes, then, we compared concurrent coding with retrospective coding. However, we recognize several kinds of "same" coding. If the principal retrospective diagnosis was coded concurrently as secondary, this was a separate category; if it was coded as third, fourth or fifth, this was separate. The reason for categorizing concurrent/retrospective coding similarities in this way has to do with DRG aggregations (see below). Table 2 summarizes the results.

Almost all cases (97 per cent) had a principal diagnosis assigned by Medical Records (retrospectively). In 35 per cent of the cases, the principal retrospective diagnosis was coded principal in concurrent Utilization Review as well; for 6.3 per cent, the retrospective code was matched, not by a principal, but by a secondary concurrent code; and for 2.8 per cent, it was matched by a tertiary code. In 53 per cent of the cases, however, the retrospectively coded diagnosis had not been coded *at all* on a concurrent basis.

Similar results were found when comparing principal procedure in concurrent and retrospective coding, although 15 per cent of the sample did not have a principal procedure assigned retrospectively by Medical Records. For 31 per cent of the cases, concurrent and retrospective coding agreed on principal procedure; and for 7 per cent, the concurrent "secondary" matched the retrospective "principal," for 47 per cent, the concurrent review did not yield the same code at all as that which would be coded by Medical Records after discharge.

For the limited number of cases for which a secondary diagnosis or procedure was assigned retrospectively, concurrent review usually did not yield the code at all. There was no secondary diagnosis for 41.6 per cent of the cases, and no secondary procedure for 40.19 per cent; the concurrent review failed to match the retrospective one that *was* assigned in 44.76 per cent of the cases on secondary diagnosis and 47.11 per cent on secondary procedure.

There is no suggestion here that concurrent coding is in error. On the contrary, by definition, concurrent review yields "the highest level of certainty supported by available clinical information." The last

TABLE 2. Matching Retrospective Principal and Secondary Codes to Concurrent Codes

	Principal Diagnosis	Secondary Diagnosis	Principal Procedure	Secondary Procedure
Retrospective code matches concurrent (%)	35.05	4.77	31.32	5.34
Retrospective principal as concurrent secondary or vice versa (%)	6.38	6.45	4.43	6.96
Retrospective code as concurrent tertiary (%)	2.82	2.41	.54	.40
No retrospective code found (%)	2.62	41.60	15.83	40.19
Retrospective code not in concurrent (%)	53.12	44.76	47.88	47.11
Total	100.0*	100.00	100.00	100.00

*Rounded numbers may not add to 100%.

concurrent review of a stay usually occurs several days before discharge; any clinical information that becomes available during those last few days cannot be reflected in the concurrent review records.

To return to the original question, then, it appears that in only about one third of the cases are concurrent and retrospective coding the same on any one diagnosis or procedure code. In some additional cases, they are "similar"—that is, the retrospective code was picked up concurrently, but it was listed as secondary instead of principal, tertiary instead of secondary, etc.

We still have not answered our original question about same overall coding; in order to do this, we must construct a four-dimensional matrix to show the interaction of sameness, similarity and difference on all four variables (two diagnoses, two procedures). For example, if a patient had the same principal diagnosis coded concurrently and retrospectively, then was the assigned principal procedure also the same? What about the secondaries?

This matrix was constructed, but only one portion of it is of interest. The DRG classification that HCFA is using differs from the original one in that principal diagnoses and procedures are used to group precisely, but secondaries are only "present" or "absent." That is, there is no discrimination based on "major" secondary codes.

Therefore, we are interested in that area of the four-dimensional matrix in which principal codes are the same in concurrent and retrospective coding and in which secondary codes are present or absent in both data sources. Only 292 cases, or 9.8 per cent, were the same in this elastic sense; that is, in only 9.8 per cent of the cases were principal diagnosis *and* principal procedure the same in concurrent and retrospective coding, while the secondary diagnoses and procedures were present or absent in both coding methods.

TABLE 3. Discrepancies in Retrospective Versus Concurrent DRGs

	No. of Cases	%
Retrospective DRG same as concurrent	684	22.984
Retrospective DRG differs from concurrent	2292	77.016

Implications for DRGs

When carrying the coding differences through the DRG aggregation process, we can expect *more* than 9.8 per cent of the cases to have the same DRG based on concurrent and retrospective coding, because each DRG is an aggregation of a number of diagnosis and procedure codes, and a certain amount of difference in the codes from the two sources will be obliterated by the grouping process.

This less sensitive measure, however, still reflected the discrepant natures of concurrent and retrospective coding, in that only 22.98 per cent of the cases remained in the same DRG (see Table 3). In general, examination of the data indicated that the major reason for a different DRG, from one data source to another, was a different principal diagnosis (as would be expected). Difference in a principal procedure was the next most likely cause. However, 17.31 per cent of all cases had different concurrent/retrospective DRGs, although the principal diagnosis and principal procedure were the same, suggesting that the secondary codes are not negligible. One hundred twenty-six of the DRGs are constructed with a simple distinction between presence and absence of a secondary code; for these, HCFA's methodology may be adequate. However, 39 additional DRGs include a distinction based on "major" versus "minor" secondary codes. The RPSLMC data support the hypothesis that accurate secondary coding is necessary for accurate DRG aggregation. This

may be a problem for the HCFA simplification of the secondary codes in the modified grouping methodology.

Results: The Magnitude and Implications of DRG Differences from Concurrent and Retrospective Coding

A measure of the magnitude of a change in DRG was constructed from data provided by HCFA, which shows the "weight" assigned to each DRG, based on a preliminary analysis of a 20 per cent sample of 1978 Medicare bills. These weights reflect a manipulation of "average cost per case" based on Medicare cost-to-charge ratios and will presumably be used in calculating the overall "hospital case mix index" as described by Bentley and Butler.[1]†† The weights are expressed in dollar figures (e.g., $1195.77 for DRG 002) and represent calculated cost per case. It is important to note that this cost is based on HCFA's sample and that it is *not* necessarily reflective of resource use at the study hospital. However, it *is* based on a limited group of peer hospitals: the "Group 4" large, urban, 685-or-more bed institutions (regardless of teaching status).

Nine DRGs do not have any weight assigned because they were inadequately represented in HCFA's sample. A total of 28 concurrent DRG assignments and 21 retrospective assignments were made to these "unweighted" DRGs (a very small percentage of the sample). In the present study, zero was used as the default weight for these cases.

It is recognized that the use of weights is problematic, since it is based on the assumption that relative average cost equals relative actual case complexity, but there exists *no other* relative weighting of the DRGs. Furthermore, with the exception of these nine DRG weights, these numbers represent probable relative (if not actual) reimbursement and are the only figures that can be used to evaluate financial impact of the new system on an institution. (HFCA has not yet released the formula that will be used to calculate reimbursement amounts. Interim reports[13,14] suggest that case mix will be used as a weighting factor along with a local wage index, teaching factor, bed size and urban/rural index. Case mix has received the highest single weight in the equations thus far developed.)

Thus, the measure of the DRG charges was a simple arithmetic difference between the retrospective DRG weight and the concurrent one. For all cases, the average concurrent derived DRG weight was $2,611. The average retrospective-derived DRG weight was $3,212.

The average net difference was $601. The shift in mean weight between concurrent and retrospective coding is significant at the 0.0001 level (t-test under equal and unequal variance hypotheses).

For this sample, then, reimbursement based on concurrent data, with case mix and local wage index as the sole determinants of payment amount, would have averaged $600 less than reimbursement based on retrospective data. For an average annual load of 7,500 Medicare patients, this represents a total loss of $4.5 million. Of course, this is a "worst case" figure, since, in fact, teaching status and other factors will affect actual reimbursement amounts; still, the question of data collection time, of concurrent versus retrospective data, is far from academic when DRGs form a basis for a reimbursement methodology.

The Reasons for the DRG Differences

An analysis of variance was performed, using the four codes' "match" status as

†† For potential objections regarding the homogeneity of resource use within DRGs, note that the contention of the researchers who developed the Diagnosis-Related Groups is that the groups permit "the classification of patients according to their patterns of resource consumption while at the same time assuring that such classes [are] medically meaningful."[10,11]

predictor variables and the net weight difference as the dependent variable.

Match status of the primary diagnosis would appear to be one major factor in explaining the net difference between concurrent and retrospective DRG. This is reasonable, since primary diagnosis is always the first-level aggregation criterion.[10,11]

An even more interesting result is the confirmation of the expected effect of the presence of procedures (especially surgical) on cost: the major factor, of the four considered, that explained the variation in net difference between retrospective and concurrent codes' "weights" was match status of the *primary procedure*.

Coding Audit

This study appeared to demonstrate substantial differences in the nature and purpose of coding clinical data between concurrent and retrospective coders. However, an alternate hypothesis might have been that one of the two coding departments had a high rate of error, yielding major differences in the resulting codes. In order to test this hypothesis, an audit was undertaken of a random sample of 100 cases in which the DRG derived from concurrent data differed from that derived from retrospective data.

Two senior coders, one from each department (Utilization Review and Medical Records), were given the patient charts and the computerized concurrent and retrospective codes. They were asked to determine why a discrepancy existed and, if an error had been made, to determine which code was correct. Some cases had more than one identifiable reason for the discrepancy; the 100 cases were assigned a total of 165 reasons. These reasons are shown in Table 4.

The cases were also analyzed by selecting the "most serious" of the reasons assigned to each, so that each case had only one reason associated with it. Most serious was defined as "closest to actual error" (see Table 5). In six cases, incorrect codes had been chosen by one or the other department; in 21 more, a clerical (keying) error meant that a code correctly transcribed on a record was incorrectly entered into the computer.

Sixty-eight of the remaining differences were determined to have been due to the correct performance of different duties in the two departments: timing differences meant that data were not always available to Utilization Review, and procedural differences meant that Utilization Review was deliberately focusing on current problems and complications rather than reviewing the entire stay. The last five cases

TABLE 4. Audit of Concurrent and Retrospective Coding Differences

Reasons for Code Differences (each case may have more than one reason assigned)	Frequency	Per Cent
Incorrect code selected by UR or MR	6	3.363
Professional judgment difference	20	12.121
Procedural difference in focus	72	43.636
Timing: data not available to UR	40	24.242
Clerical error in data entry to computer	25	15.152
Other	2	1.212
	165	100.000

UR = Utilization Review department.
MR = Medical Records department.

were simply "judgment calls," in which there was some room for professional difference of opinion about the precise code to be selected.

Overall, this audit appears to refute the hypothesis that either coding department was in error, but to support the hypothesis that concurrent clinical data reflect a coding process different from that of retrospective data and that the two may differ without either one being in error.

TABLE 5. Audit of Concurrent and Retrospective Coding Differences

Most Serious Reason for Code Differences (each case has only one reason assigned)	Frequency
Incorrect code selected by UR or MR	6
Clerical error in data entry to computer	21
Timing: data not available to UR	34
Procedural difference in focus	34
Professional judgment difference	5
	100

UR = Utilization Review department.
MR = Medical Records department.

Conclusions

The data upon which the Health Care Financing Administration plans to construct its new reimbursement mechanism may be inappropriate for that use. In how many hospitals were those data collected concurrently instead of retrospectively? In their concern for timely bill submission,‡‡ Medicare officials and hospital administrators may have unwittingly elected to sacrifice "final" diagnostic and procedural data. The concurrent data provided a problem indication that was sufficient for the reimbursement purpose of the time; it is, however, *not* sufficient for its proposed new purpose. Any provider who submitted concurrent data in past years may have distorted the case mix and runs a risk of incorrect—possibly inadequate—reimbursement under the new regulations.

Until the data can be adequately reviewed and explained, or replaced with appropriate retrospective data, and the differences between billing and clinical data eliminated, the current case mix based on Diagnosis-Related Groups cannot be used to measure resource use and therefore will not accurately predict reimbursement needs.

As Corn so astutely observes, "the producers of discharge data are not the principal users of the data . . . it appears that it is up to the data users to focus attention on the production of discharge data and to encourage uniform controls of their quality."[3]

In this case, the major "data user" is HCFA: the agency proposes to "focus attention" on discharge data by implementing a reimbursement system based on case mix. It seems evident that hospitals that supplied concurrent data during 1978 must furnish HCFA with retrospective data for that year, in order to establish a reliable data base of DRGs and associated costs. (It should be noted that the JCAH-mandated "Disease and Operations Index," maintained in each hospital, is an easily accessible source of this data.) Old data, however, are undoubtedly error-prone, as described in the Institute of Medicine study; Medicare providers and Medicare regulators will have to work together in coming years to improve the quality of the data before reliable case-mix reimbursement can be implemented.

‡‡ ". . . in 1979 . . . Medicare days at 49.3% . . . represent the highest number of revenue days outstanding for December 31 of any year since the survey began. . . . All payors registered increased days revenue in receivables over the same quarter last year . . . the 'Grand Total' for the quarter is 67.8% inpatient receivable revenue days outstanding." From: Chicago Hospital Council Memorandum No. 77, "Inpatient Receivable Survey Report—December 31, 1979." Chicago Hospital Council, April, 10, 1980.

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A Case-Mix Method for Developing Health Planning Criteria for Hospital Services

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The principal concern of this article is the inadequacy of the planning criteria currently being used by existing federally funded health planning agencies. A case-mix method was created for developing appropriate criteria. Chart-abstract data from New Jersey were used to create a list of those diagnoses eligible for treatment in the cardiac care unit (CCU), select a sample of hospitals for study and analyze the relationship between CCU bed need and CCU clinical practice. It was shown that existing bed-need criteria for CCU planning represent current CCU clinical practice patterns, which are probably not cost effective. The method was also used to develop empirical values of these criteria, which do represent cost-effective practice. It is recommended that the method be used to strengthen and update continuously all hospital-service need criteria used in current planning activities, including Plan Development and Certificate of Need Review.

RISING CONCERN over the escalating cost of health care[1-5] led Congress in 1974 to require that the Secretary of the Department of Health, Education and Welfare prepare and issue by regulation "National Guidelines for Health Planning."[6] Since then, resource standards have been issued as part of the Guidelines for a limited number of health care services, including acute-care hospital beds and computerized tomographic (CT) scanners.[7-9]

These standards are inadequate for the planning and regulation that health systems agencies and state health planning and development agencies currently undertake. They do not, for instance, cover many available health care services, such as cardiac care units and skilled nursing facilities. In addition, some of the standards, including those for acute-care hospital beds, have not been shown to be based on efficacious, cost-effective medical practice.‡ Also, none of them provides enough information to allow planners to adjust standards to reflect factors, such as socioeconomic status, that may cause variations in the need for services at the local level.[10,11]

A recent Institute of Medicine report states that the development of guidelines for health planning and regulation has been hampered by inadequate data bases, limitations in existing health planning

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‡ As used in this study, cost-effective treatment means the least expensive form of treatment which has been proven to be therapeutically effective for the clinical conditions under consideration.

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analytic techniques and research methods, and insufficient knowledge of the efficacy of many health care services.[10] There is, therefore, an urgent need for a strengthening of the quantitative, analytic infrastructure of the health planning system. Specifically, there is an urgent need for empirically validated need criteria and procedures for adjusting these criteria to match local conditions in all existing health care facilities.

The research described in this article represents an attempt to address some of the issues raised in the Institute of Medicine report. Specifically, the authors developed and employed a new, inexpensive, flexible method for using hospital chart abstracts to create and analyze empirical values of need criteria. This method can also be used for the development of procedures for adjusting need criteria so that they account for the effect of local conditions on bed need.

The method allows the planner to go beyond the Lee–Jones methodology of the 1930s, which based criteria for determining the need for health care services on physician-defined clinical norms.[12] It achieves this by allowing for the use of evidence based on clinical research and on existing clinical practice in the creation of need criteria. Hence, it offers planners the opportunity to create and update need criteria continuously in order to reflect accurately optimal, current clinical treatment, and to use these criteria to plan for the rational allocation of the nation's health care resources.

Methods

A detailed description of the work on which this article is based has been presented elsewhere.[13] A brief synopsis is offered here.

The DRG Data Base

The New Jersey CCU system was selected as the field laboratory for this study because the state's health department has developed a comprehensive, statewide, computerized, hospital chart-abstract data base (the Diagnosis Related Group—DRG—data base) that is admirably suited for the field testing conducted in this research.[13]

CCU Bed-need Criteria

On the basis of a review of 207 health systems plans and annual implementation plans from health systems agencies across the country and of several other relevant documents on CCU planning,[14–17] nine different CCU bed-need criteria, which are currently being used by health planners, were identified.[13] Of these, the five criteria listed in Table 1 were chosen for further study.

These five criteria were chosen on the basis that, taken together, they provide the planners with the ability to determine CCU bed need in all regions of the country, no matter how rudimentary the local planning data base. The other four were not selected because none of them improves planners' ability to determine CCU bed need above that provided by the five criteria that were selected.[13] One of the criteria that was not selected, for instance, was the number of CCU admissions per 1,000 service area population. In order to use this criterion, the planner would require data on CCU service area population. However, if these data were available, the planner could use the third criterion that was chosen—the number of CCU beds per 100,000 service area population (see Table 1).

List of CCU-Eligible Diagnoses

A fundamental principle underlying this research is that the need for CCU beds depends primarily on case mix, which we have defined through an examination of diagnosis. A patient with a complicated acute myocardial infarction, for instance,

will need a CCU bed, whereas a patient with only a simple pelvic fracture will not. In order to use diagnosis as a basis for determining CCU bed need, we required a list of those diagnoses that would make patients eligible for treatment in a CCU. A group of practicing northern New Jersey cardiologists directed the creation of this list. The list is based on the experience of this group of cardiologists, a review of the CCU literature and data derived from the DRG data base.[13]

The resulting list of CCU-eligible diagnoses, which was expressed in both H-ICDA-2 and ICDA-8 codes§ because both of these coding systems were used in New Jersey in 1977, was divided into seven categories. These categories, which were considered distinct in terms of their clinical characteristics and also in terms of CCU resource utilization, are listed in Table 2.

Selection of Hospitals for Study

Nineteen New Jersey hospitals were then selected for use in the study. They were selected because they had separate CCUs, rather than CCUs combined with intensive care units (CCU–ICUs), or no CCUs, and because of their accuracy in reporting CCU treatment in their chart abstracts.[13] Measured in terms of eight hospital characteristics, the sample of 19 hospitals was very similar to the whole population of New Jersey acute-care hospitals (Table 3). The 19 hospitals reported 225,886 chart abstracts in 1977, of which 9,193 were coded as having been CCU treated and which contained diagnostic codes on our list of CCU-eligible diagnostic codes. In other words, the empirical values of the CCU bed-need criteria reported here are based on a sample of 9,193 chart abstracts.

§ This list of H-ICDA-2 and ICDA-8 codes is available from the first author upon request.

TABLE 1. Five CCU Bed-Need Criteria Chosen for Study

Criterion	Range of Values Now Used By Planners
Optimal average length of stay in the CCU	(2 to 6 days)
Optimal ratio of all CCU admissions to myocardial infarction CCU admissions	(1.5 to 2.5)
Expected no. of myocardial infarction admissions per 1,000 population	*
Optimal no. of CCU beds per 100,000 population	(3 to 12)
Optimal no. of CCU beds per 100 general-care beds	*

* No values for these criteria were found in our review of health planning documents.[13]

Measures of Current CCU Practice

Having thus defined a list of CCU-eligible diagnoses and selected the 19 hospitals for study, we proceeded to use

TABLE 2. Categories of Diagnoses Treatable in the CCU

DICAT No.	Diagnoses in DICAT*
1	Simple acute myocardial infarction (AMI)
2	Complicated AMI
1 + 2	AMI (simple or complicated)
3	Intermediate syndrome
4	Rule-out MI
5	Cardiac arrhythmia problems
6	Intensive cardiac conditions treatable in a regular intensive care unit
7	Other CCU-eligible cardiac conditions not often seen in the CCU
1–7	All CCU-eligible diagnoses
8	Diagnoses which are not eligible for CCU treatment

* DICAT represents diagnostic category.

TABLE 3. Comparison of the 19 Selected Hospitals With All New Jersey Acute-Care Hospitals (1977)

Characteristics	19 Selected Hospitals	All NJ Hospitals
% Hospitals with residency programs in internal medicine*	10.5%	21.7%
% hospitals with residency program in cardiology*	5.3%	8.5%
Average no. of maintained CCU beds†	8.7	8.8‡
CCU occupancy rate§	79.9%	73.1%‡
% hospitals that have separate CCUs§	100%	29.2%
Average no. of hospital beds§	288	256
% hospitals that are governmental¶	5.3%	4.7%
% hospitals that are proprietary¶	5.3%	5.7%

* Source: Directory of Accredited Residencies in Internal Medicine, Annual Report on Graduate Medical Education in the United States, 1977–1978, American Journal of Cardiology, A.M.A.

† Source: New Jersey Department of Health.

‡ The value of this rate for all New Jersey hospitals is based only on hospitals with separate CCUs.

§ Source: "New Jersey General Hospital Facility Complement and Patient Data," 1977 Annual Summary (revised), New Jersey Department of Health, June 1978.

¶ Source: Health Facilities Evaluation List of "Licensed General Hospitals in New Jersey," New Jersey Department of Health, June 1978.

them to define two measures of current CCU practice that are important in the determination of CCU bed need: CCU admitting criteria and CCU discharge criteria.[13]

This was achieved by first using the chart abstracts from the 19 hospitals to calculate the percentage of patients with CCU-eligible diagnoses who were treated in the CCU in each of the 19 selected hospitals in 1977, by diagnostic category. These data are presented in Table 4 and show, for instance, that in hospital 3, 49.0 per cent of all the patients discharged with simple AMI (DICAT 1) were treated in the CCU and that 29.3 per cent of patients discharged with complicated AMI (DICAT 2) were treated in the CCU. This finding was true in most of the 19 hospitals (Table 4) and was contrary to our original expectation that a higher proportion of complicated than of simple AMI patients would have been treated in the CCU.

The average values of these percentages in the 19 hospitals were used as measures of the stringency or looseness of the CCU admitting practices in these hospitals. Hence, hospital 39, for example, which treated the smallest percentage (5.2 per cent) of all admitted patients with any CCU-eligible diagnosis (DICATs 1–7) in the CCU, was considered to have the most stringent CCU admitting practices in the group of 19 hospitals. Similarly, hospital 12, which treated the largest percentage (26.1 per cent) of its admitted patients with any CCU-eligible diagnosis (DICATs 1–7) in the CCU, was considered to have the loosest CCU admitting practices.

The average CCU lengths of stay of CCU patients treated in the 19 hospitals in 1977 were taken as measures of the CCU discharge practices in the sample of 19 hospitals (Table 5). Thus, hospital 14, for example, which exhibited the longest average length of stay in the CCU for patients with any CCU-eligible diagnosis (DICATs 1–7), was considered to have very loose CCU discharge practices. Similarly, hospi-

TABLE 4. Percentage of CCU-Treated Discharges in Each of the 19 Selected Hospitals by DICAT (1977)

Hosp No.*	% Discharges With CCU-eligible Diagnoses CCU Treated in the following DICATS								
	Dicat 1	Dicat 2	Dicat 1 + 2	Dicat 3	Dicat 4	Dicat 5	Dicat 6	Dicat 7	Dicat 1–7
3	49.0	29.3	40.9	25.0	4.4	12.3	11.2	1.0	10.2
12	84.3	70.6	80.2	63.7	22.2	21.3	11.9	2.6	26.1
14	64.1	54.9	59.7	45.7	11.1	16.5	8.0	1.5	16.8
16	45.9	49.3	47.0	27.0	5.8	13.8	7.9	1.7	11.4
20	83.3	63.5	73.4	50.0	11.5	12.0	7.8	.8	14.7
26	85.1	66.2	77.9	69.9	12.4	16.4	14.3	1.4	19.7
29	83.2	75.5	81.0	51.6	16.8	26.1	31.3	4.8	21.6
39	34.9	25.3	32.5	13.1	1.7	3.7	2.9	.7	5.2
47	79.0	86.7	81.3	53.2	11.9	21.1	6.7	1.0	20.6
48	82.7	86.0	83.4	69.0	11.3	25.7	22.9	4.8	20.4
51	61.0	40.8	54.7	39.3	11.2	15.1	4.8	1.3	14.1
56	63.0	50.0	58.7	46.2	10.5	18.5	9.1	3.4	19.5
57	59.7	79.6	64.3	61.3	7.8	29.8	18.4	2.0	18.8
58	77.1	76.5	76.9	77.8	25.6	34.3	15.6	2.9	23.5
78	85.2	84.1	92.4	72.0	10.3	26.1	22.1	1.9	18.2
80	73.3	75.6	74.4	29.0	5.7	14.5	12.7	.4	6.9
85	64.1	66.7	65.3	43.3	3.4	20.2	15.5	.8	12.0
92	73.1	91.9	81.4	61.7	10.8	41.9	24.7	2.3	24.6
112	43.8	56.8	47.7	27.0	7.1	12.8	17.1	2.3	13.9
Mean	68.0	64.7	67.0	48.7	10.6	20.1	13.9	2.0	16.8
SD	15.8	19.3	16.6	18.5	6.0	9.0	7.5	1.3	5.8
Coeff. of Var. (%)	23.2	29.8	24.8	38.0	56.6	44.8	54.0	65.0	34.5

* These numbers were used in our data processing.[13]

tal 78, which had the shortest average length of stay in the CCU for patients with any CCU-eligible diagnosis (DICATs 1–7), was considered to have very stringent CCU discharge practices.

Empirical Values of CCU Bed-need Criteria

These measures of CCU admitting and discharge practices in the 19 selected hospitals, together with our list of CCU-eligible diagnoses, were the basic elements of our case-mix definition of current CCU practice that was used to calculate empirical values for the five selected CCU bed-need criteria (Table 6). The empirical values in Table 6 are average values for the 19 hospitals in the study. The empirical value for the first criterion, 4.25 days, for instance, was taken as the average length of stay in the CCU for patients with any CCU-eligible diagnosis (DICATs 1–7—see Table 5). The value for the second criterion was based on counts of the number of discharges with AMI and counts of the number of CCU-treated discharges, with both counts determined using chart-abstract data. Calculation of the third and fourth criteria made use of the size of each hospital's CCU service area, which was determined by means of a CCU patient-origin study, also using chart-abstract data.[13] The last two criteria made use of values of the number of CCU beds needed in each hospital, which was based on the number of CCU patient days actually used by CCU-treated patients with CCU-eligible diagnoses who were discharged in 1977. This latter calculation was also performed with the use of chart-abstract data.[13]

TABLE 5. Average Length of Stay in the CCU (Days) in 19 Selected Hospitals by Diagnostic Category (1977)

Hosp. No.*	Dicat 1	Dicat 2	Dicat 1–2	Dicat 3	Dicat 4	Dicat 5	Dicat 6	Dicat 7	Dicat 1–7
3	4.77	7.48	5.58	4.82	5.77	4.91	4.23	7.00	5.25
12	4.82	5.78	5.07	3.20	2.87	3.08	3.06	2.57	3.60
14	10.22	10.09	10.16	8.67	7.41	8.39	7.36	6.55	8.65
16	4.50	7.35	5.48	3.34	3.69	4.75	3.85	3.14	4.38
20	8.10	9.00	8.49	4.09	3.46	4.01	2.85	2.33	5.36
26	4.44	3.87	4.26	3.31	3.09	3.37	3.34	2.66	3.58
29	3.00	ǂ	3.00	2.00	2.50	2.66	12.00	ǂ	3.75
39	5.87	7.60	6.19	3.89	3.51	4.04	4.33	2.80	5.00
47	5.33	5.82	5.49	3.65	3.20	3.61	5.20	1.00	4.14
48	4.00	5.81	4.41	2.62	2.05	2.89	2.38	2.04	2.87
51	4.80	6.16	5.11	3.64	3.15	3.30	2.95	2.70	3.85
56	4.77	7.61	5.56	4.55	3.67	3.77	4.50	3.28	4.63
57	4.15	5.89	4.64	2.93	2.77	3.50	3.31	2.66	3.40
58	3.59	5.84	4.32	3.57	2.71	4.70	3.22	1.50	3.48
78	3.66	2.00	3.25	ǂ	3.11	1.81	4.00	1.00	2.75
80	5.80	5.96	5.88	4.34	3.39	3.59	4.55	1.00	4.43
85	6.20	5.00	5.63	3.67	3.61	3.92	5.18	7.00	4.35
92	4.73	5.77	5.25	2.99	2.89	4.00	3.83	2.33	3.64
112	4.36	6.12	4.98	2.78	2.71	3.41	3.03	2.00	3.54
Mean	5.11	6.28	5.40	3.75	3.45	3.83	4.38	2.98	4.25
SD	1.68	1.80	1.63	1.40	1.22	1.33	2.17	1.91	1.30
Coeff. of Var. (%)	32.9	28.7	30.2	37.3	35.4	34.7	49.5	64.1	30.6

* These hospital numbers were used in our data processing.[13]

ǂ Values were not able to be calculated for these elements because of poor coding of length of stay in the CCU on the chart abstract.

Study of the bed-need criteria in the 19 hospitals revealed considerable hospital-to-hospital variation. For example, the hospital-to-hospital variation in the first criterion listed in Table 6 (average length of stay in the CCU) is illustrated in Table 5. This type of hospital-to-hospital variation in such bed-need criteria suggests hospital-to-hospital variation in such factors as: maintained CCU bed levels; CCU admitting and discharge criteria and treatment practices; CCU patient characteristics; and CCU service-area characteristics.

A statistical analysis of CCU utilization in the 19 hospitals helped explain these variations in the empirical values of the bed-need criteria. This analysis considered the effect of factors such as clinical severity, patients' ages and CCU occupancy rates. Incidentally, this statistical analysis was also used to illustrate the development of procedures for allowing the health planner to adjust CCU bed-need criteria to account for factors which cause a legitimate, abnormally high or low CCU bed need on the local health service area level. As a result, it was concluded that the case-mix method is well suited for the development of such adjustment procedures for need criteria for all hospital facilities. This has been reported elsewhere.[13]

Although there were considerable hospital-to-hospital variations in the empirical values of these criteria, there was close agreement between the average value based on our definition of current CCU practice and that based on the actual numbers of CCU beds maintained in all 19

TABLE 6. Empirical Values of CCU Bed-Need Criteria in 19 Selected Hospitals (1977)

Bed-Need Criterion	Values Based on our Definition of Current CCU Practice*		Values Used By Health Planners
	Mean	SD	
Average length of stay in CCU (days)	4.25	1.30	2 to 6
No. CCU Discharges per AMI discharge	2.58	.65	1.5 to 2.5
No. AMI discharges per 1,000 service-area population	2.26	.57	†
No. CCU beds per 100,000 service-area population	6.28	1.30	3 to 12
No. CCU beds per 100 general care beds	1.99	.53	†

* Current CCU practice is based on our list of CCU-eligible diagnoses and the CCU admission and discharge practices in the 19 selected hospitals.

† No values were found for these criteria in our search of planning documents.[13]

hospitals (see Table 7).[‖] This suggested that the number of CCU beds in the 19 hospitals, taken as a group, was close to need, based on our definition of current CCU practice in 1977. However, this was not necessarily true in individual hospitals in the group.

Empirical values of the CCU bed-need criteria were generally close to or in the range of values used by CCU planners (Table 6). However, the range of values used by planners is extremely broad (Table 6), broader than seems appropriate for planning criteria. Use of values at the upper end of the range could lead to unnecessarily high CCU bed levels, utilization and expenditures. Similarly, use of values at the lower end of the range could lead to unnecessarily low CCU bed levels and high cardiac mortality rates. This underlines the urgent need for a far narrower range of empirically based CCU bed-need criteria.

Cost-effective CCU Bed-need Criteria

In an attempt to fill this need and in order to develop cost-effective CCU bed-need criteria, we used the case-mix approach and chart-abstract data from the 19 selected hospitals to calculate the values of bed-need criteria representing cost-effective CCU care.[13] A cost-effective CCU was defined as one that admits only patients with diagnoses for which the unit is the least expensive proven mode of therapeutically effective treatment, and that uses therapeutically sound but stringent discharge criteria. The selection of diagnoses for which the CCU has not been rigorously proven to be cost-effective, those in the first, fifth, seventh and eighth

‖ There are only two criteria in this table because only two of the five selected CCU bed-need criteria could be related to the number of maintained beds (see Table 1).

TABLE 7. Average Empirical Values of CCU Bed-Need Criteria in 19 Selected Hospitals Based on Our Definition of Current CCU Practice and on the Number of Maintained Beds in 1977

Bed-Need Criterion	Value Based on No. of Maintained CCU Beds	Values Based on Our Definition of Current CCU Practice*	
		90% Bed Availability†	Average Bed Need‡
No. of CCU beds per 100 general care beds	3.11	3.10	1.99
No. of CCU beds per 100,000 service-area population	10.20	9.85	6.28

* Current CCU practice is based on our list of CCU-eligible diagnoses and the CCU admission and discharge practices in the 19 selected hospitals.

† In order to be able to compare with the number of maintained CCU beds in each hospital, our case-mix estimate of average bed need was used to calculate bed need for 90% bed availability, using the Poisson formula.[13]

‡ These values are from Table 6.

diagnostic categories in Table 2, was based on our review of the CCU literature.[13]

The selection of stringent discharge criteria was achieved by selecting an appropriate but low average CCU length of stay. For this purpose, the average CCU length of stay in hospital 48 (see Table 5) was selected, based on an examination of the average length of stay in the CCUs in the 19 selected hospitals.[13] Hospital 48 was selected because it had the lowest average length of stay for CCU-eligible discharges (DICATs 1–7) of the hospitals that provided enough well-coded chart-abstract data to allow for the calculation of average lengths of stay for each of the seven CCU-eligible diagnostic categories (Table 5). Hospital 78, which had a lower average length of stay for CCU-eligible diagnoses than hospital 48, was not selected because it did not provide enough chart-abstract data to enable the calculation of values of average length of stay for all seven diagnostic categories considered in this study (see Table 5). Hence, it was felt that use of data from hospital 78 might not yield representative empirical values of CCU bed-need criteria.

The resulting values of the cost-containment-oriented CCU bed-need criteria representing cost-effective CCU care were at the lower end of the ranges of values found in our review of CCU planning documents and literature (Table 8). They were used as a basis for recommending values of the five selected CCU bed-need criteria (Table 8) for CCU planning. In the interest of cost containment it is recommended that planners use these bed-need criteria until rigorous clinical trials support the expansion of the use of the CCU beyond the level on which the recommended bed-need criteria are based. When used for planning on the local, area-wide level, these criteria should be adjusted to account for factors that effect CCU bed need on the local level.

Discussion

The use of chart abstracts and the case-mix method for determining empirical values of need criteria is a powerful, efficient approach with several disadvantages. Probably the most serious disadvantage is that this approach uses the chart abstract as

TABLE 8. Values of Five CCU Bed-Need Criteria

Bed-Need Criterion	Empirical Value Based on Cost-Effective Treatment	Value Recommended for Planning	Values Used by Health Planners
Average length of stay in CCU (days)	2.98	3	2 to 6
No. CCU discharges per AMI discharge	1.65	1.5	1.5 to 2.5
No. AMI discharges per 1,000 service-area population	0.92	1	*
No. CCU beds per 100,000 service-area population	2.82	3	3 to 12
No. CCU beds per 100 general care beds	0.90	1	*

* No values for these criteria were found in our review of health planning documents.[13]

a data source. Chart abstracts contain errors, some of which are frequent and serious.[18,19] These errors derive from the fact that the abstracting process introduces errors of omission, miscoding and misinterpretation, and superimposes them on the errors or lack of documentation existing in the patient's chart.

Due to the burgeoning use of chart abstracts for health care reimbursement and evaluation,[20] chart-abstracting errors have been rather extensively studied.[18,19,32] Table 9, for instance, contains some of the results of a 30-hospital reabstracting study conducted by the Health Research and Educational Trust, an affiliate of the New Jersey Hospital Association.[19] These results suggest that two of the abstracted items used in this study, the discharge and admission dates, were reliably coded—the rate of agreement between the original code and the reabstracted code for both items was 99.7 per cent. On the other hand, they also suggest that principal and secondary diagnoses, which were important variables in our study, were rather poorly coded—with rates of agreement of 72.6 per cent and 66.5 per cent for principal and secondary diagnoses, respectively.

While these findings might argue that diagnosis was poorly coded, it should be pointed out that the HRET abstracting study considered the order in which diagnosis was coded. This was not a critical concern in our research because we used all diagnoses on the chart abstract, without regard to their order on the abstract.

Another disadvantage that could be attributed to the case-mix method is that it is only usable in areas of the country in which chart-abstract data bases have already been created. This is because the expense of creating a chart-abstract data base large enough to provide reliable information for the purpose of using this method de novo would probably not be justified when compared with the lesser expense of using one of the other methods of creating need criteria, such as past utilization or direct examination of a sample of patients or their charts.

There are only about 10 states in which chart-abstract data bases are currently being collected for use in the public do-

TABLE 9. Rates of Agreement Between HRET and Original Abstracts

Data Item	Rate of Agreement (%)
Date of birth	99.3
Sex	98.6
Race	96.9
Zip code	98.7
Admission date	99.7
Discharge date	99.7
Patient disposition	98.7
Principal payment source	97.5
Principal diagnosis	72.6
Secondary diagnosis	66.5
Other diagnosis	52.9
Principal procedure	66.4
Secondary procedure	59.3
Other procedure	44.0

Source: "Reliability of New Jersey Hospital Discharge Abstracts: Final Report," Health Research and Educational Trust, Princeton, NJ, July 1978.

main, so that this method is only usable in a small portion of the U.S. This implies that the method is probably not now feasible for the creation of need criteria representing clinical practice in most of the country. However, chart-abstracting organizations such as the Professional Activities Study do collect and process chart abstracts for most hospitals in the other states, so that this method could conceivably be used in all areas of the country. This is not now possible because, as a rule, hospitals do not make chart-abstract data available for public use.

One of the most significant advantages of the case-mix method is that it is able to use very large samples of patients and providers at very little expense in areas which have publicly available chart-abstract data bases. The 1,109,286 1977 New Jersey hospital chart abstracts used in this study, for example, were obtained at a cost of a few hundred dollars. The reason for this is that the expense of creating the New Jersey hospital chart-abstract data base is borne by the state, the federal government and other third-party payers. Funds also derive from the state's federally funded prospective reimbursement demonstration project.[20]

Two of the most powerful features of this method are that it is based on case mix and that it is able to incorporate the results of clinical research and other empirical information. These features enabled the method to be used for the characterization, analysis and evaluation of the clinical norms currently being used by CCU cardiologists. Similarly, these features account for the method's ability to specify clinical norms representing what we consider to be cost-effective CCU care, and to determine bed-need criteria representing this cost-effective care.

This result seems important because all existing need criteria are based on subjective, physician-specified clinical criteria, which presents several problems. The first is that physicians often differ widely in their specification of "appropriate" clinical criteria. In addition, there is a considerable body of literature suggesting that physicians sometimes use clinical criteria that yield treatment practices that have not been proven to be efficacious or cost-effective.[21–28] As an example, the acute-care hospital bed-need criterion of 4 beds per 1,000 population,[7] issued by the Department of Health, Education and Welfare—now called Health and Human Services—has been criticized by many physicians as being too skimpy. However, studies of bed need in HMOs suggest that this criterion could safely be lowered to about 2.5 beds per 1,000 population.[21,29] It has been suggested that this difference of opinion can be accounted for by the differences in clinical criteria used by physicians in HMOs and in fee-for-service practice. This does not necessarily indicate clinically inappropriate practice on the part of either HMO or fee-for-service practitioners. It could simply be a reflection of the lack of validated, specific norms for the need for clinical treatment.

Conclusions and Recommendations

Use of chart abstracts and the case-mix method has yielded results that suggest

that the CCU bed-need criteria now being used by health planners are generally representative of current CCU practice (Table 6), which, on the basis of available evidence, is probably not cost-effective. The range of values of CCU bed-need criteria currently being used by health planners is too broad to allow for the allocation of CCU facilities in a rational, cost-effective manner.

In an attempt to strengthen the methods available to planners, therefore, we used the case-mix method to develop CCU bed-need criteria that do represent cost-effective CCU care, and we recommend their use for cost-containment-oriented CCU planning. In addition, in the interest of reducing unnecessary expenditures on CCU care in a rational therapeutically valid manner, it is strongly recommended that a rigorous clinical evaluation of current CCU practice be undertaken.

The case-mix method underlying this study is a powerful, inexpensive tool for relating the clinical, cost and utilization aspects of hospital care, and it is recommended that it be used, together with the chart-abstract data bases currently being created in several states, to validate and extrapolate the conclusions of this study. This includes the validation of our empirical values of CCU bed-need criteria (Tables 6 and 8). It also includes the development of adjustment procedures for CCU bed-need criteria so that they are able to account for factors that do cause legitimate extraordinary CCU bed need on the local level. This should be based on a comprehensive analysis of such factors as service-area population socioeconomic and demographic characteristics, which cause variations in CCU bed need on the local level.

The case-mix method should also be used to evaluate the cost-effectiveness of other forms of hospital care and the planning criteria used in their need determination. Where necessary, empirical values of need criteria representing cost-effective treatment and adjustment procedures for use on the local level should be developed. This should be done for services such as the intensive care unit, intermediate cardiac care unit, general care and diagnostic services such as the CT scanner and the electronic fetal monitor. This is particularly important in this time of concern over the increasing cost of health care, which has led to an urgent need to allocate health care services in a cost-effective and therapeutically valid manner.

Implementation of these recommendations would provide the health planner with continuously updated, empirically based need criteria that do represent cost-effective and therapeutically effective clinical practice, and that also account for clinical, demographic, geographic and socioeconomic variables that have a valid effect on the need for health care services. These criteria would be suitable for use by existing planning and reimbursement agencies for certificate of need review, plan development, appropriateness review and rate setting.

Although chart-abstract data have become increasingly available to individual hospitals, such data have not been readily available to planning and regulatory agencies, or for research purposes. While the Social Security Administration, and now the Health Care Financing Administration (HCFA), have been receiving these data on a 20 per cent sample of Medicare patients,[30] most other chart abstracts have not been in the public domain. A few states, including New Jersey and New York, now require the submission of discharge abstracts on all patients as part of HCFA-funded demonstration projects.

The controversy concerning the costs and benefits of implementing a uniform hospital financial report[31,32] suggests that the creation of a nationwide system for collecting chart abstracts will depend on the ability of planners, regulators and researchers to document the need for these data. Hopefully, this paper will strengthen the case for collecting and disseminating chart-abstract data for purposes of understanding and ra-

tionally regulating and monitoring our hospital system.

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Why Do Nursing Home Costs Vary?

The Determinants of Nursing Home Costs

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Since the costs of nursing home care are a major component of the rapidly rising costs of health care, it is appropriate to base public policy discussions about cost containment on the determinants of nursing home costs. This article investigates the determinants of nursing home operating costs and reviews the results of 11 related econometric cost analyses conducted by the authors. Single-equation cost analyses are developed for nursing homes in three states and in the nation. The cost results of a multi-equation model of nursing home behavior are also reviewed. The analyses indicate that facility size and occupancy rate are minimally important in determing cost variation. Facility characteristics, particularly type of facility and ownership, are important variables. Nonprofit facilities consistently had higher costs than for-profit facilities, after controlling for patient mix and service differences, and, in one analysis, for a measure of quality.

THIS ARTICLE REVIEWS and integrates the results of 11 distinct econometric cost analyses conducted by the authors on 20 sets of nursing home data.[1] The data include information on costs, services produced, and characteristics of residents and facilities. The analyses include:

- a single-equation cost model for a national sample of 1,127 nursing homes, using the 1973-74 National Nursing Home Survey, from a survey conducted by the National Center on Health Statistics;
- a multi-equation, two-stage least squares (2SLS) model of nursing home behavior that includes a cost equation as well as equations for services provided, occu-

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[1] The approach used in this paper to synthesize results across the multiple data sources is similar to that used in a related review of some of the nursing home cost literature in Bishop.[1] An interpretation of the results described in this paper for use in improving nursing home reimbursement policy is contained in Birnbaum et al.[2]

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pancy rates, the mix of public and private patients, and the rate charged to private patients. These analyses were conducted using the national sample of nursing homes mentioned above;

- three single-equation cost models of nursing homes in New York, using the Medicaid Cost Reports for facilities in that state. Separate cost analyses were conducted on approximately 500 facilities for each of three years: 1974, 1975 and 1976;
- three single-equation cost models of nursing homes in Massachusetts, using the Medicaid Cost Reports for facilities in that state. Separate cost analyses were conducted on approximately 450 facilities for each of three years: 1973, 1974 and 1975;
- three single-equation cost models of nursing homes in Indiana, using Medicaid data for facilities in that state. Separate cost analyses were conducted on approximately 80 facilities for each of three years: 1973, 1974 and 1975.

The econometric studies used distinct sets of nursing home data, for different times and for different geographic areas (Table 1). The "cost function" analysis has identified variables that are statistically significant in explaining variation across providers and in assessing the magnitude and direction of their effects. The cost function of economic theory is a measure of the relationship between average cost per unit of output and rate of production However, the cost analyses described here also allow average cost to vary systematically by provider type, input price level and output.

The various econometric analyses were reasonably successful in accounting for the variation in the dependent average operating cost variable. Across the data sets, the explanatory variables explain or predict between 59 and 77 per cent of the variation. The studies also show that many variables are strongly and consistently associated with operating costs. However, it can be misleading to compare actual regression coefficient values across the studies, since the other variables "held constant" by regression analysis differ. Also, the time periods differ.

Average operating cost is measured as per diem total cost net of reported capital-related expense.# For a variety of reasons, it

The implicit assumption is that the production of nursing homes should be measured in patient days rather than in cases treated. Since nursing homes generally provide ongoing supportive and residential services to individual patients with chronic disabling conditions, it would be inappropriate to use the episode or case as the unit of output.

TABLE 1. Description of Nursing Home Samples

Geographic Location	Year	No. of Providers	R^2*	Data Source
Nationwide	1972	1127	.585	National Center for Health Statistics
Massachusetts	1973	453	.656	Massachusetts Dept. of Public Health
	1974	468	.713	Rate Setting Commission
	1975	438	.719	
New York	1974	479	.647	New York State Dept. of Health
	1975	504	.768	
	1976	504	.764	
Indiana	1973	78	.721	Indiana Dept. of Public Welfare
	1974	86	.471	
	1975	82	.545	

* Proportion of variation explained by the regression.

would have been inaccurate and inappropriate to include the costs of capital. From the point of view of economic theory, accounting costs of capital are unlikely to reflect the opportunity cost of capital. In addition, reported costs reflecting expenditures for plant and equipment (depreciation, interest, rent) are unlikely to vary systematically with the independent variables reflecting scale and product mix, because these expense figures are determined by historic construction costs, age of the facility, method of financing and ownership types, as well as by the type and number of patient days provided. Moreover, there appears to be little substitution between capital and labor in the production of nursing home days, and reimbursement systems typically use different rules for reimbursement of capital and operating expenses.[3–5]

Summary of Results

Scale of Production

While average operating costs tend to decline as occupancy rate increases, i.e., as a facility is used to capacity, the studies find that the facility size, measured in number of beds or average daily census, is generally unimportant.¶ These results are summarized in Table 2.

The estimating procedure allowed costs to rise or fall over various size ranges by using Fuller's[5] "grafting" procedure. While average costs were found to fall initially as the bed size increases to about 40 beds, costs were not related to size beyond that level. Since diseconomies of scale were not present for intermediate to large nursing homes, these results do not support the notion that there is some optimal nursing home size. Relatively small facilities appear to have reached an efficient size.

¶ Average daily census is a measure of the rate of production equivalent to size (measured in number of beds) and capacity utilization (represented by occupancy rate) used in combination: average daily census equals occupancy rate times number of beds.

The instability of the results over time for New York and Massachusetts suggests that the impact of regulation on facilities may be as important as underlying economies of diseconomies of scale and utilization. Over the period studied, rate-setting authorities varied the size groupings used to set rate limits in Massachusetts and New York, and differing penalties were applied to low-occupancy providers. These regulations apparently encouraged changes in provider behavior, as shown in Table 2. For the national analysis, which could not capture variation in state rate-setting treatment of size classes, size and utilization appear unimportant except for very small-scale effects over the lowest census range.

Provider Type: Ownership

The cost studies consistently found that facilities operated by nonprofit voluntary and government organizations have higher costs than for-profit nursing homes, by at least several dollars per day (Table 3). The studies have controlled for patient mix and services offered, and the New York study includes inspection-rating data that may be thought to control for quality of care. Nonetheless, the cost differentials between for-profit, nonprofit, and government providers persist. It is possible that the profit incentive encourages for-profit operators to be more efficient, so that they produce similar outputs with fewer inputs and lower costs.

Rate regulation appears to have played a role in producing these cost differentials, particularly in New York. The New York results for ownership differed over the three years studied. The New York rate-setting system grouped facilities by ownership in 1974 and 1975, so that nonprofit facilities knew their rates would be less limited than those of their for-profit counterparts. A nonprofit facility had little incentive to cut costs so long as costs were typical of nonprofit providers. For-profit and nonprofit facilities were grouped to-

TABLE 2. Effect of Scale of Production on Average Operating Cost

Sample	Independent Variables: Beds — Effect per additional beds	Independent Variables: Occupancy Rate — Effect per additional % point	Average Daily Consensus — Effect per additional patient
National			
1972	—	Insignificant	Negative then insignificant: costs fall by $0.20 per unit ADC for range 1–20 flat thereafter
Massachusetts			
1973	Range 40–79: −$0.02	Range: 0– 90%: −$0.23 95– 97%: −$1.19 97–100%: +$0.46 Costs higher by $2.92 per day when occupancy is above 90%	
1974	Negative insignificant	Range: 0–90%: −$0.21 90–93%: $1.23 95–97%: −$0.59 Costs lower by $1.69 per day when occupancy is above 93%	
1975	Negative insignificant	Range: 0–90%: −$0.12 95–97%: −$0.85 Costs higher by $0.161 per day when occupancy is above 95%	
New York			
1974	Insignificant	Range: 80–90%: −$0.20 Costs higher by $4.89 when beds greater than 300	
1975	Insignificant	Insignificant	
1976	Range 1–49: $0.10 Costs less by $2.23 when 200–299 beds	Insignificant	
Indiana			
1973	—	Insignificant	
1974	—	Insignificant	
1975	—	Insignificant	
National, 2 SLS			
1972	Positive: +$0.10 per bed	Negative: −$0.02 per percentage point	

gether in 1976 for the first time, and the cost differential fell, decreasing from $5.96 to $4.14. This decrease in the otherwise increasing nonprofit/for-profit cost differential indicates that the nonprofit facilities have responded to the change in rate setting.

The nonprofit/for-profit differentials in Massachusetts between facilities were lower than those in New York. In this re-

gard, it is significant that Massachusetts did not treat facilities differently by ownership for purposes of reimbursement.

Input Prices

The level of input prices clearly affects operating costs. The index of regional wage levels, proxied by the average retail wage in the county of facility location, was positively and significantly associated with the level of operating costs in the national and New York analyses. The county wage variable was not statistically significant in the Massachusetts analyses; however, counties in Massachusetts are much less compact than counties in other parts of the country and do not meaningfully represent labor market areas.

Another potential measure of input price variation was the geographic location of the home. In all cases, region was significantly associated with operating costs, as shown in Table 4. For example, in the national analyses, the per diem operating costs of homes in the Northeast were almost $4.00 greater than those of homes in the West; homes in the Central and South regions had costs of approximately $2.00 more than those of homes in the West. Analogous results were found for homes in different areas of Massachusetts and New York. It was expected that costs would be higher in urban areas, even after wage levels were accounted for, but this hypothesis was not supported in the single-equation national mode. However, in the two-stage least squares (2SLS) national model, which did not include regional location and found wage rates insignificant, SMSA location did have a significant effect on average operating cost. A further measure of input price, the actual average wage for licensed practical nurses in the facility, was included in the national and New York analyses. In both cases, this measure was positively and significantly related to operating costs.

TABLE 3. Effect of Ownership on Average Operating Cost Estimated Incremental Cost Relative to For-Profit Ownership

Sample	Nonprofit Voluntary	Government
National		
1972	$1.74	$2.52
Massachusetts		
1973	3.58	—
1974	3.66	—
1975	2.73	—
New York		
1974	7.08	9.43
1975	5.96	11.60
1976	4.14	10.30
National, 2SLS		
1972	+$1.36 for nonprofit and government combined	

Product Characteristics

The most difficult problem for nursing home cost studies is a proper description of the product of the nursing home. Cost function estimation can proceed only if the product is assumed to be homogeneous, or if product differences can be accounted for by including product mix descriptors among the independent variables. Three types of product descriptors have been used in these nursing home cost studies: 1) certified level of care; 2) measures of service availability and intensity; and 3) patient characteristics. Patient turnover and source of payment might also be treated as patient characteristics or product descriptors. These variables are discussed below.

Certified Level of Care. Certification status is a direct measure of product type, since skilled nursing facilities (SNFs) and intermediate care facilities (ICFs) are required to meet different standards. However, as discussed earlier, the definition and enforcement of these standards, while subject to federal guidelines, differ across states. Consequently, the services provided by SNF in one state may not be the same as those in another. Certification

TABLE 4. Effect of Location and Input Price Variables on Average Operating Cost

Sample	Independent Variables		
	Region	Urban Area: SMSA or Population Density	Wage Rates
National			
1972	Northeast: + $3.62 Central: + $1.78 South: + $2.60	Insignificant	Retail wage, county: + $0.97 Nurse wage, facility: + $2.78
National, 2SLS			
1972	—	$1.06	Insignificant
Massachusetts			
1973	Significant cost differences among intrastate regions	—	—
1974			
1975			
New York			
1974	Significant cost differences among intrastate regions	Insignificant	Retail wage, county: + $6.51
1975	"	Insignificant	Retail wage, county: + $6.29 LPN wage, facility: + $0.70
1976	"	Insignificant	Retail wage, county: + $6.83
Indiana			
1973	—	Insignificant	Nursing home wage, county: + $3.59
1974	—	Insignificant	Insignificant
1975	—	Insignificant	Insignificant

level also proxies the type of patients, to the extent that patients are placed systematically according to need. Again, however, the effectiveness of the process that matches level of need to level of care apparently varies across states. The cost studies show that more complex (SNF) levels of care are indeed associated with higher costs (Table 5), but the differential varies across states.

Another reason for expecting differences between the costs of SNF and ICF providers is that, as with the size groupings and the nonprofit/for-profit distinction discussed above, certification status (SNF versus ICF versus combined SNF–ICF) is used by states as a grouping criterion for rate setting. In fact, this is the only grouping criterion required under federal guidelines for state rate setting.** As discussed above, when a criterion is used to group facilities, it is probable that cost differences between groups will be reinforced and perpetuated by the grouping itself. Given an initial difference in average cost between the groups, a rate-setting method that relies on group means sets rates or rate ceilings that differ between the groups by an amount approximating the initial average cost differences. There is no reason to expect this differential to diminish over time, since on average it will be paid by the rate-setting systems.

Further insight into the value of certified level of care as a predictor of cost is found

** During the period in question federal regulations required that SNF rates be higher than ICF rates.

in the 2SLS national model. Once nursing hours per patient day are accounted for, the SNF–ICF distinction does not add significantly to the explanation of cost. This implies that it is not level of care per se, but rather the associated nursing intensity that contributes to cost.

Output Descriptors: Services. Although information on services received by patients and services available was not complete, the service variables used did contribute to the explanatory power of the cost equations. Residual F-tests performed on the two data sets with relatively complete service information—the New York data and the national data—show that these variables are significant as a group, as shown in Table 6.

The endogenous service intensity variables included in the national 2SLS model, nursing hours per patient day and an index of rehabilitative-type services provided, were highly significant predictors of average operating cost. This result further supports the hypothesis that care differing in intensity differs in cost.

The inclusion of service intensity variables possibly raises methodological problems. While it is reasonable to assume that a day of nursing home care that includes three hours of licensed nursing care is a different product from a day with minimal nursing input, inclusion of a variable representing nursing hours per patient day could merely underline the obvious: nurses cost money (i.e., a day of care with higher nursing intensity costs more). Inclusion of variables for "intermediate" products, such as units of services provided to patients (for example, the per cent of patients receiving oxygen therapy, nasal feeding, catheterization, etc.) as in the national study, is perhaps theoretically preferable to direct inclusion of input variables like nursing hours. Equations including such service variables will estimate the average cost of providing the services as "add-ons" to the basic nursing home day of care. On the other hand, regulatory standards are often set up in terms of the minimally required nursing intensity, and the inclusion of that variable thus has practical importance.

TABLE 5. Effect of Certification as a Skilled Nursing Facility on Average Operating Cost

Sample	Differential Cost of SNF Over ICF Certification
National	
1972	$2.13
National, 2SLS	
1972	Insignificant
Massachusetts	
1973	$4.24
1974	$4.53
1975	$5.77
New York	
1974	$8.97
1975	$8.82
1976	$11.20
Indiana	
1973	$2.11
1974	$2.50
1975	$1.15

The results with respect to the number of beds per room, a proxy measure for quality, are relatively consistent across states. It costs more to provide care to patients in private rooms than to patients in rooms with two or more beds.

These results have clear implications for rate setting, for there are problems with using service-intensity variables as product descriptors. If more nursing hours change the product of a nursing home, a facility that uses nurses wastefully will not be identified as inefficient, but rather as producing an above average type of care. A facility providing excessive amounts of services, and perhaps keeping patients overly dependent, would be seen as providing a different product from more efficient counterparts that serve similar patients more effectively, but with fewer "doses" of service. If it could be assumed

TABLE 6. Effect of Services on Average Operating Cost

Sample	Independent Variables	
	Service Availability in Facility	Service Delivered to Patients
National		
1972	7 offered services significant as a group; for example: Occupational therapy (OT): + $0.86 Physical therapy (PT): + $0.91 Proportion of beds in rooms of 3 sizes: insignificant	13 variables representing % receiving specific services: insignificant as a group
Massachusetts		
1973	Insignificant	—
1974	PT + $0.86 Care significantly less expensive in rooms with 4+ beds	—
1975	PT: + $0.85 Care significantly more expensive in single rooms	—
New York		
1974	—	—
1975	Seven offered services: insignificant Care significantly more expensive in single rooms	8 variables representing number of services by type per patient day: significant as a group; e.g., +$3.14 per PT visit per patient day
1976	—	8 variables representing number of services by type per patient day: significant as a group; e.g., $1.25 per patient day
National, 2SLS	Proportion beds in rooms of three sizes: significant	Index of services delivered: significant Nursing hours per patient day: +$3.29 per hour

that patients receive appropriate care accross facilities, patient status variables could be used to account for product differences, and there would be no need to include actual services provided. However, this has not been possible because of inadequate quality and patient status data.

Patient Characteristics. Conceptually, days of care provided to different types of patients are different products. Therefore, the cost studies used patient descriptors as product characteristics—so that the estimated cost functions predict the cost of basic nursing home care with cost "add-

TABLE 7. Effect of Patient Characteristics on Average Operating Cost

Sample	Independent Variables				
	Activities of Daily Living	Diagnoses	Mental States	Age	Sex
National					
1972	Insignificant	Significant	Depressed patients add to cost	Insignificant	Insignificant
National, 2SLS					
1972	Insignificant	Significant	—	Insignificant	Insignificant
Massachusetts					
1973	Insignificant	Insignificant	Insignificant	90+: $7.07	Insignificant
1974	Nonambulatory: +$1.73	Insignificant	Insignificant	90+: $3.26	Insignificant
1975	Nonambulatory: +$2.13	Insignificant	Insignificant	Insignificant	Insignificant
New York					
1974	Nonambulatory: +$3.34	—	—	Insignificant	Insignificant
1975	Eight variables significant as a group	—	—	Insignificant	—
1976	Insignificant	—	—	Insignificant	Insignificant

ons" for specific characteristics of the facility's patient mix.

The available patient descriptors were of four types: 1) age; 2) diagnosis; 3) level of dependence in activities of daily living (ADL); and 4) mental impairment. Patient differences may also be described by sex, but there was no a priori reason to expect cost differences between otherwise similar women and men. Increases in the magnitude of the case-mix variables can be hypothesized, in general, to correspond to increased dependence and need for care, and thus to increased cost. Table 7 summarizes the results.††

With one exception,‡‡ age variables, which might be expected to reflect debility that increases with age, were not found to add significantly to explanatory power. The proportion of female to male patients was never found to have a significant influence on average operating costs.

Measures of dependence in ADL, when considered as a group, did not add significantly to explanatory power in the national equation. However, econometric problems preclude strong inference from this result.

The New York measures of ADL appeared less complete, but did add significantly to explanatory power. When the number of patients requiring assistance with eating rises by one percentage point, average cost increases 4.5¢ per patient day; a one-percentage-point increase in those requiring assistance with bathing raised cost 3.2¢ per day; and a need for assistance with correspondence added 2.3¢ per day for each percentage point in patient mix.

In Massachusetts for 1974 and 1975, only one ADL-related variable was available, percentage of patients who were nonambulatory. Increasing the proportion of

†† The national data base had the largest array of patient descriptors. However, because the patient information there was based on a sample, each variable was subject to considerable error. The error would tend to bias the regression coefficients in the national equations toward zero. The absence of accurate quality measures also adds bias to the patient mix coefficient estimates.

‡‡ In Massachusetts in 1973 and 1974, it was found to be significantly more costly to care for those aged 90 or above.

nonambulatory patients by one percentage point was found to increase cost by 1.5¢–3.5¢ per day.

Variables representing patient mix by diagnosis added significantly to the explanatory power of the estimated equation in the national analysis, but not in Massachusetts, where only a limited amount of diagnostic information was available. New York had no information on case mix diagnosis.

In summary, only a few kinds of patient status variables were significant in explaining cost, and the effect of particular variables is not consistent, either across years or across data sets. As in the case of services, this may be due to problems of measurement. However, the finding of general insignificance is also consistent with the hypothesis that resources expended for apparently similar patients differ widely across facilities. Cost per patient day depends more on the facility's ongoing staffing level and target level of quality than on patient needs determined in some objective sense. However, in the only data base that had measures of quality—New York—ADL variables are significantly associated with cost and consistent with the hypothesis that for the same level of "quality," a more debilitated patient is more costly.

Patient Turnover. Average length of stay may be seen as a patient variable, distinguishing short-stay patients recuperating from acute illnesses from patients who need long-term nursing and personal care. However, the variable may also describe the type of care being provided (maintenance versus rehabilitation) or the discharge policies of the facility.§§ Our studies show that high patient turnover is associated with higher per diem costs, either because of fixed costs per admission (administrative costs or the high cost of early days of care) or because of differences in patient or care type (Table 8).

Source of Payment. Conceptually, the source of payment for a given patient is a product descriptor only if patient needs or care provided vary systematically by payment source, and if the systematic differences have not already been controlled in the analysis. In any event, a facility's product type may vary by whether it serves mainly private or public (Medicaid) patients, or a mixture of these. Facilities oriented toward the private market may produce a different type of care, perhaps with a higher amenity level and commensurately higher costs than facilities serving primarily public patients. Alternatively, if private patients are more sensitive to price than public patients, and if rate setting for public patients is done on a full-cost reimbursement or pass-through basis, facilities serving more public patients may have higher costs. In addition, the per cent private pay available may reflect the effects of rate setting, utilization review and standards enforcement in facilities serving public patients.

Findings about the effect of the proportion of public-pay patients differ across the studies. (Table 9). In Massachusetts per diem costs were lower in public-pay-oriented homes, and in New York costs were higher. The coefficient of the payment proportion variable is insignificant in the national study. This result is not surprising, since the national results could average out the differences found in New York and Massachusetts. When an endogenous variable indicating per cent private pay was included in the national 2SLS model, with service intensity variables held constant, a strong negative effect on cost per patient day was observed. This result may be interpreted as showing that providers produce a given type of nursing home care (as indicated by the intensity

§§ Alchian[7] points out that with the volume of output held constant, average cost should fall as the number of production periods rises. In this context, length of stay may be interpreted as a proxy for the number of production periods.

TABLE 8. Effect of Admission Rate on Average Operating Cost

Sample	Estimated Coefficient* for Admissions Per Patient Day	Effect on Average Cost of Additional Admission for Typical Provider
National		
1972	$419	$0.017
National, 2SLS		
1972	$185	$0.007
Massachusetts		
1973	$377	$0.015
1974	$262	$0.010
1975	$113	$0.005
New York		
1974	$342	$0.014
1975	$1,050	$0.042
1976	$276	$0.011

* The coefficient on the variable "admissions per patient day" shows the effect on average cost of increasing the rate of admissions (that is, decreasing the average length of stay). The coefficients can be put into perspective in two ways. First, consider the effect on costs per patient day of an additional admission, which depends on the number of patient days. For the average nursing home surveyed by the National Center for Health Statistics in 1976, providing 23,962 patient days in that year, one more admission would have raised the admission rate from 0.00302 to 0.00306 (computed from NCHS, 1979). The effect of such a change on average cost per patient day for the cost studies is shown in the table. Alternatively, consider the effect on total annual costs of one more admission per year, again for the same number of patient days. The estimated equation shows the following relationship:

$$\text{average cost} = \frac{\text{total annual cost}}{\text{patient days per year}} = b \times \frac{\text{annual admissions}}{\text{patient days}} + \text{other factors}$$

where b is the coefficient of the admission rate. Multiplying through by patient days,

$$\text{total annual cost} = b \times \text{annual admissions} + \text{other factors.}$$

This implies that one more admission adds $b to total annual costs. These values are shown in the estimated coefficient column.

variables) in a more efficient manner for private clientele who pay out of pocket than for public patients, for whom the government pays.

Interstate Differences in Reimbursement and Regulation

The national cost equations included variables describing differences in state regulation and reimbursement practices. In the single-equation model, nursing homes in states with prospective reimbursement were estimated to have higher costs, by $1.40 per patient day, than homes under cost-related or flat-fee reimbursement systems. The 2SLS national model, which accounts for simultaneous relationships among endogenous variables, also found that facilities in prospective reimbursement states had higher costs than those in cost-related reimbursement states. The coefficient for flat-rate reimbursement systems was insignificant, implying that flat-rate and prospective systems act similarly on costs. This result could be spurious for a variety of reasons. The result may be due to problems of equation specification and omitted variables—for example, omission of adequate quality measures. Alternatively, higher costs may initially be allowed by prospective systems to obtain nursing home operator approval of a system that places them at risk for unforeseen

TABLE 9. Effect of Private-Pay Patient on Average Operating Cost

Sample	Increment to Cost Per Percentage Point Private Pay*
National	
1973	Insignificant
National, 2SLS	
1972	−$0.020
Massachusetts	
1973	$0.025
1974	$0.045
1975	$0.051
New York	
1974	−$0.040
1975	−$0.036
1976	−$0.061
Indiana	
1973	Insignificant
1974	−$0.017
1975	Insignificant

* It would be misleading to interpret these results as showing the incremental cost of a private patient over that of a public patient in one facility. It may be assumed that public and private patients do not receive different care once they have been admitted to a facility; this may not be true if homes have separate public and private wings, but such practices are directly contrary to public policy and are not allowed under certification regulations. Therefore, the coefficient of percentage private pay is believed to proxy the commitment to the private market.

events. Or, it may be that the cost ceilings used in retrospective systems are more cost constraining than the rates set under prospective reimbursement. Another explanation might be that those states with excessively high nursing home costs adopted the prospective approach in an effort to "solve" their cost problem. An appropriate test for the effect of prospective reimbursement would be to observe homes before and after statewide adoption of prospective reimbursement.

The single-equation cost model also found that other state regulations appear to affect the costs of nursing homes. Homes in states with life-safety codes have higher costs, by about $0.75; nursing homes in states with inflexible nursing staff requirements have higher costs, by $1.45; similarly, occupancy penalties significantly and positively affect costs. Several other regulatory variables—including the presence of a certificate of need program, preadmission patient assessments and a uniform chart of accounts—have positive but statistically insignificant cost impacts. Finally, reimbursement systems that put limits on total payments to nursing homes or on administrative salaries may be successful in reducing costs. However, the negative coefficient was not statistically significant.

Some of these policy variables achieved significance in the 2SLS cost equation, which did not include region variables. For example, certificate-of-need programs were found to be significantly related to higher costs (by $2.43 per day), as were the staffing requirement variables and the requirement of a uniform chart of accounts. These findings suggest that regulation and reimbursement fall into regional patterns and are probably related to and caused by the previous cost, access and quality performance of the state's nursing home industry. This suggests that analyses of the association between cost and regulatory practice at one point in time may be unreliable for predicting the likely effect elsewhere.

In concluding this discussion, some overall comments on the results of the multi-equation 2SLS results are appropriate. The results underline the extent to which simultaneity issues pervade analysis of nursing home behavior. It is found, for example, that an increase in service intensity increases operating costs, but also that it increases the occupancy rate and the percentage of private patients in a home, and that both of these latter effects are cost-decreasing. Furthermore, regulation and rate setting are seen to have a variety of effects on policy-relevant vari-

ables other than cost. In particular, reimbursement variables also affect service intensity, to rates charged to private patients and the public–private mix of patients. The demand for nursing home care by private-pay patients was found to be elastic with respect to price. In addition, private-pay patients were found to be paying higher rates than public patients, and cost-controlling reimbursement features were found to increase the differential. In other words, private patients appear to be subsidizing public patients. The conclusion, then, is that appropriate rate-setting practices cannot be formulated directly on the basis of cost analyses. Rather, the results underline the importance of a more comprehensive understanding of the nursing home environment if unintended and undesirable consequences of rate setting are to be avoided.

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